NEW DEVELOPMENTS IN SUGAR BEET MACHINERY

By

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The experimental work for improving sugar beet machinery was originated and is being continued by a number of agencies for three reasons: (1) large amounts of hand labor are necessary to grow the crop and production costs are therefore high, (2) hand labor is required in two very distinct and comparatively sharp seasonal peaks, and (3) there is an imminent shortage of sugar beet labor and has been even during the recent years of extreme unemployment.

Numerous studies have been made to determine production costs and labor requirements of different crops, sugar beets among them. Recent figures from California, where sugar beet production is on a large scale, show that 75 man hours per acre are required to grow the crop. Of this, 36% is for thinning and hoeing in the spring and 33% is for topping and loading at harvest time or a total of 52 man hours per acre of contract labor. These figures are probably below the average for the entire United States.

There is, of course, a more or less uniform labor requirement for seed bed preparation, planting, cultivation, irrigation and harvest, but the large demand for sugar beet labor comes in the spring for thinning and hoeing and in the fall for topping and loading. In California where the thinning and harvest seasons are comparatively long, these labor peaks are high and that in the spring is especially sharp. This means that large crews of men are necessary for comparatively short periods and must find other work or lie idle for considerable time. In the other sugar beet sections where the thinning and harvest seasons are shorter the labor peaks are even sharper and the situation would be worse if it were not for the diversification of crops.

Near labor shortages occurred in California last fall during sugar beet harvest and this spring during thinning. In other sections much of the beet work is done by the grower's family or by other white labor. In California, family labor represents a negligible part of that used for thinning, hoeing, topping and loading the crop. The work is done under contract, largely by Mexicans and Filipinos. It is expected that many of

the latter will take advantage of the free transportation to the Philippine Islands provided by the Government.

The experimental program of the Bureau of Agricultural Engineering and cooperating agencies on sugar beet machinery has chiefly been aimed at the reduction of these two seasonal labor peaks. It has consisted largely of work on equipment for hill planting, mechanical blocking and thinning, harvesting and some special problems or practices which have developed, particularly crust breaking at seed germination time and bed or ridge planting.

The usual practice of growing sugar beets is to drill the seed in a continuous row at a rate of 18 to 20 pounds of seed per acre. After the seedlings are up and well established they are thinned to single plants usually at about 10 or 12 inch intervals. On an average stand the thinning operation reduces the number of seedlings in a hundred inches of row from between one and two hundred to about eight or ten.

The planting of sugar beets in hills was suggested as it would have the following advantages over the usual practice: It should reduce the spring labor peak by eliminating blocking from the blocking and thinning operation. It would save seed, thereby decreasing production costs. The 20 pounds of seed usually used costs $3.20 at the present price of 16 cents per pound. Hill planting requiring seven to eight pounds of seed per acre would not cost over $1.28 resulting in a saving of nearly $2 per acre. Hill planting should also result in a more uniform stand which would tend to increase production. It is thought that perhaps fertilizers could be used more advantageously with beets in hills. It is also thought that hills of beets could more easily break through soil crusts which often form following rains at germination time.

The Bureau of Agricultural Engineering, working with the California and Colorado Agricultural Experiment Stations, began experimental work on a hill planter for sugar beets about four years ago. It was known that beet seed dropped irregularly because of its roughness and its low density of 18 to 19 pounds per bushel. One commonly used planter with a celled seed plate drops bunches of seed on seven inch centers yet the seed actually reaches the furrow in a more or less uniform drill. It was thought that the difficulty which would be encountered in building a hill planter for the crop would be to get compact enough hills.

Some experimental work had already been done at Ames, Iowa, on a hill planter using a corn planter type mechanism for sugar beets. It was found that the flapper valves would only work up to about 90 times per minute. Such a speed would give 23.5 inch hills at two miles per hour forward travel of the planter. Sugar beets are desired at 10 to 12 inch intervals, sometimes closer. It was therefore decided to use a seed plate acting as a rotary valve for the hilling mechanism. One row models were designed and built using a seed plate in a vertical plane. Seed cells in the circumference of the plate accumulated seed as they passed through a seed hopper, carried the seed downward and discharged it near the bottom of the opened furrow. The peripheral speed of the seed plate was approx-

imately equal to the forward travel of the planter and as the plate turned in the direction of forward travel, it virtually functioned as a wheel running on the ground though it was power driven. The seed in the cells therefore was practically stationary with respect to the ground at the time of discharge and as the drop was only an inch or two, there was practically no seed scatter. Both roller and plunger seed ejectors were used on different models to effect positive dropping of the seed. After a satisfactory mechanism was developed, units were constructed to use on a field planter and experimental plantings were made.

The farm machinery industry has also been experimenting with hill planters for sugar beets during the past few years and a number of machines have been built. Two manufacturers now have hill planters for sugar beets on the market. One of these had five machines in California last season. Experimental plantings were made with these planters and with the planter developed by the Bureau and its cooperators. Stand counts and thinning studies were made on these plantings.

It was found that beets could be satisfactorily planted in hills with either type machine. The planter which had been developed by the Bureau gave especially compact hills. This compactness of hill was noted on the first experimental plantings made during the development stage and it was thought then that such hills might be difficult to thin commercially. This later proved to be true in some cases.

The experimental hill plantings gave the following results: The seed saving amounted to from 60 to 65%. Approximately 17% of the thinning time was saved on sedimentary soil beets. On peat land in the Sacramento River Delta, however, where germination conditions were ideal and the stand very good, the seedlings in each hill were thick and closely grouped and it took 22% longer to thin the hill planted beets than comparable drill stands. The usual drill seeding rate on the peat is less than the customary 20 pounds per acre of other soils and the seeding rate for the hill planter probably should have been less.

An objectionable feature of the hill planting appeared in the experimental plantings, namely the loss of entire hills during the thinning operation. Where the seedlings in the hills were very compactly grouped and especially on the loose peat soils where the growth was rapid and the roots quickly became interwoven, it was difficult to pull out all but one seedling. Often all seedlings in the hill came out together. Losses ranged from 13.6% on sedimentary soils to 19.7% on late thinned, peat land beets. In general it was found that the hills were slightly too compact. This difficulty can be remedied however and changes have been made in later machines to increase the seed scatter. More machines have been put out this season and an increased acreage has been hill planted.

Mechanical cross blocking was developed a few years ago and has been discussed at a previous meeting. A description is given in U.S.D.A. Leaflet 97 entitled "Cross Blocking Sugar Beets by Machine" which was published in 1933. This practice of blocking the beets mechanically using an ordinary cultivator equipped with weeder knives spaced to leave the desired size

blocks and working crosswise of the rows is increasing in popularity. In many areas it is the accepted system. Because large acreages can be rapidly covered the timeliness of the operation is especially important to some growers, particularly in California where the demand for hand labor at blocking and thinning time is high.

A new development in mechanical blocking is its experimental use for mechanical thinning. Knives with a two-inch cut are set on three-inch centers thus leaving four uniformly spaced, one-inch blocks per foot of row. A number of these inch blocks will contain single seedlings and others two or three. By using a long handled hoe for thinning and leaving some doubles the labor of thinning is materially reduced and satisfactory stands were obtained.

A formula was developed, in connection with the cross blocking, for determining the theoretical after-thinning stand from the germination stand, the width of cut of the knives and the width of beet blocks left. Using this same formula for one inch blocks left with two inch blanks between and on a good stand of beets, there would be over two hundred beet-containing blocks per hundred feet of row. From previous ordinary cross blocking work it was determined theoretically that around seventy of the inch blocks would contain single seedlings.

Counts made on a plot experimentally thinned showed that there were 209 beet-containing blocks left per 100 feet of row and of these 65 contained singles. The average beet in the mechanically thinned plot was smaller at harvest time than a comparable hand thinned beet in an adjacent plot, but there were more marketable beets per 100 feet of row in the mechanical thinning. The yield of the machine thinned beets was slightly higher.

The fall labor peak in producing sugar beets occurs at harvest time. More experimental work had been done to develop machinery to do this job mechanically than has been done on all other phases of mechanizing the crop. Experimental machines have been built for many years and numerous patents have been granted, yet we still do not have a sugar beet harvester in commercial production and in general use. However, it looks as though we may have a commercially acceptable machine before long.

Harvesters have been of two general types, those topping the beets in the ground and elevating the topped roots and those elevating the beets, tops and all, and topping in the machine. Of the harvesters of the former type, that is topping in the ground, none has as yet been satisfactory and not particularly because of unsatisfactory topping. Some of the machines have done a fairly satisfactory job of topping using a floating topping knife, sometimes reciprocating or revolving and on other machines stationary. Height of topping has been gaged by shoe, wheel or track.

In general, the greatest difficulty with this type of harvester has been the separation of beets from clods after the beets have been topped and elevated. Many devices have been tried for mechanical separ-

ation such as shaking or bumped conveyors, piercing type pickup wheels and conveyors with a rubbing or rolling action. Hand separation has also been tried but under cloddy conditions there were too many clods to be picked from the beets and the beets came up too fast for a reasonable number of men to pick them from the clods.

There are at present several harvesters of the topping-in-the machine type in various stages of development. One has progressed to the point where it seems to be very near the commercial stage. It was started several years ago from a commercial red beet harvester built by the same company. One of the earlier models was described at the December meeting in 1931 by E.M. Mervine and the paper was later published in Agricultural Engineering.

Successive models have been built each year since. The harvester has evolved from a heavy, expensively constructed, self-propelled machine to one much lighter and less expensive. It is a trailer or pulled machine using a power take-off from the pulling tractor to drive elevating and topping mechanisms. It is now a 2,600-pound machine comparable in mechanical construction to a corn picker. It is a single row machine which can readily be pulled by a tractor of 20 or 22 drawbar horsepower even in hard, dry, heavy soil.

The machine has a pair of gathering points similar to a corn binder which straddles the row being harvested and lifts the leaves. A pair of rubber-faced elevating chains grasps the beet tops and at the same time a lifting plow running directly under the beet row loosens the roots. As the harvester travels forward the elevating chains carry the beets back and upwards, thereby lifting them by the tops nearly vertically out of the ground. The beets are elevated to and grasped by a pair of roller bars. This unique mechanism works the beet top up between the moving bars until the crown is against the bottom of the bars which gage it for topping. At the same time the roller bars move the beet back to the two revolving disk topping knives. These disks have serrated edges and turn towards each other, in that way pulling the beet into the knives as it is topped. The disks are set at an angle which gives an inverted V or roof-like cut to the top of the beet.

The topped beets are dropped onto a cross conveyor elevator which carries them to a small hopper holding about 200 pounds. They are thrown over a gap from the end of the elevator into this hopper to effect a separation from leaves and dirt. The operator on the machine dumps the beets in piles forming cross windrows.

The crowns and tops are carried back from the knives to a cross conveyor. This conveyor has an intermittent drive engaged by the operator to dump the tops in piles also forming cross windrows. The tops are thus saved for feed in better shape and with less loss than by much of the hand harvesting.

Two of these harvesters were built this past year. One was tested in three districts in California and in Colorado. The other was used in Ohio. In California the machine was tested on sedimentary soil, partial sediment, and peat soil, to determine its possibilities under the different conditions

found there. Performance tests were made later in Colorado to determine the comparable quality of its work.

The harvester was found to do very creditable work where the beets were at all uniform in tops and in height above the ground. An occasional beet was missed because its crown stuck up above the ground or because of a poor top but in general the tops were satisfactory for the harvester. On the partially sedimentary soil, where some of the tops were poor because of a spring attack of mildew, the loss from beets missed in the field was less than 2 per cent. Counts made on a number of hand harvested fields in California showed an average loss of $2\frac{1}{2}$ per cent.

An occasional beet topped in the machine had to be hand trimmed by the operator, but the average topping job done by the harvester was comparable with the usual run of hand topping. In general the machine performed in a most encouraging manner and a number of growers and sugar company representatives who visited it in operation were very enthusiastic about it.

The following results were obtained during the performance tests made during the early part of the harvest season in Colorado.

	Hand Harvested	Machine Harvested
Dirt tare	7.86%	4.68%
Top tare	.84%	1.15%
Total tare	8.70%	5.83%
Low topping loss	1.46%	2.2 %
Beets missed tonnage	2.4*%	.38%
Total loss	3.86%	2.58%
Weight saved due to "roof" of machine cut		2.1 %
Net loss	3.86%	.48%
Beets missed number		1.02%

* Average loss in several California fields.

Under some field conditions the harvester did not do as good work as the above table shows. However, under average conditions or better the machine apparently does topping equally as good as or better than hand work.

This harvester, as has been mentioned, dumps the beets from a hopper into piles forming cross windrows. There is no reason why the elevator to the hopper could not be extended and carry the beets directly into a truck. However, for experimental uses the small hopper is preferable and for commercial use in the eastern areas where individual acreages are smaller, the hopper seems quite satisfactory.

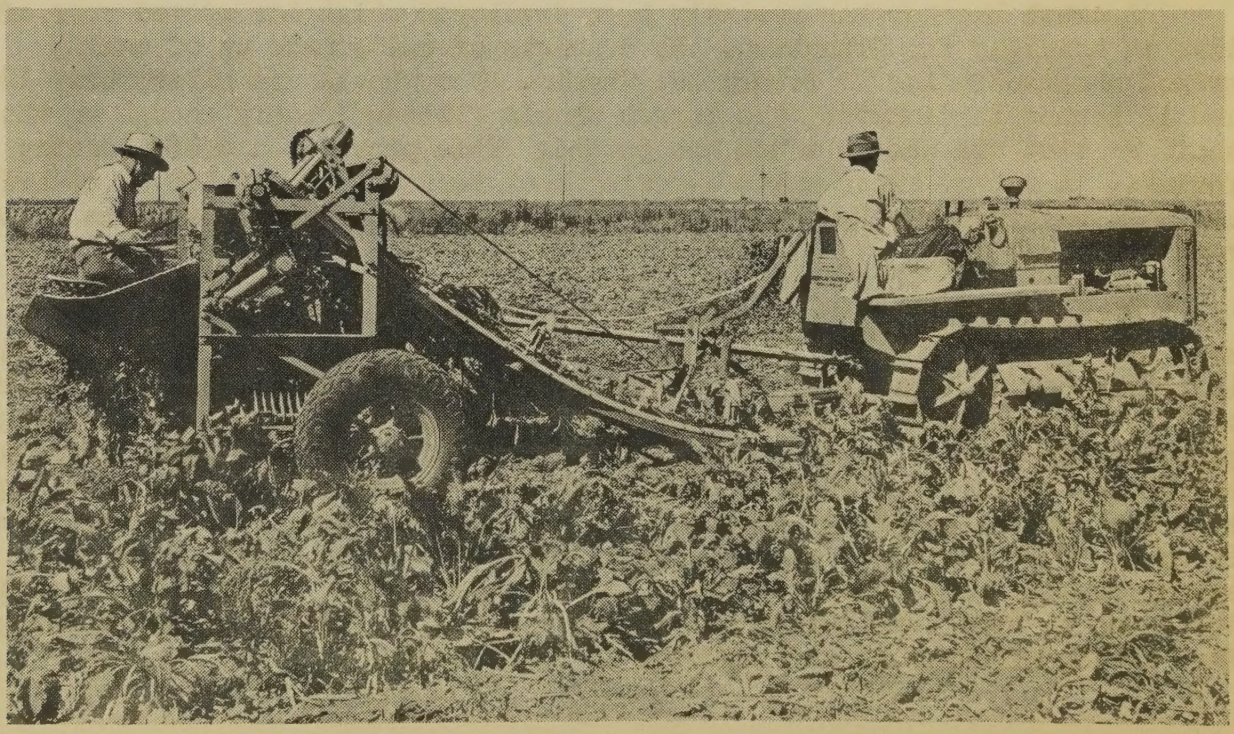
We understand that the company is building six machines for this season's harvest. Some minor changes are being made in the hitch and power-take-off and some points are being strengthened, but, in general, the machine will be similar to last year's harvesters.

Other problems than that of reduction of labor peaks have come up in the sugar beet machinery research. One that occurs more or less each year is that of soil crust formation following rains at seed germination time and the breaking of this crust. Many different kinds of equipment have been tried with varying degrees of success.

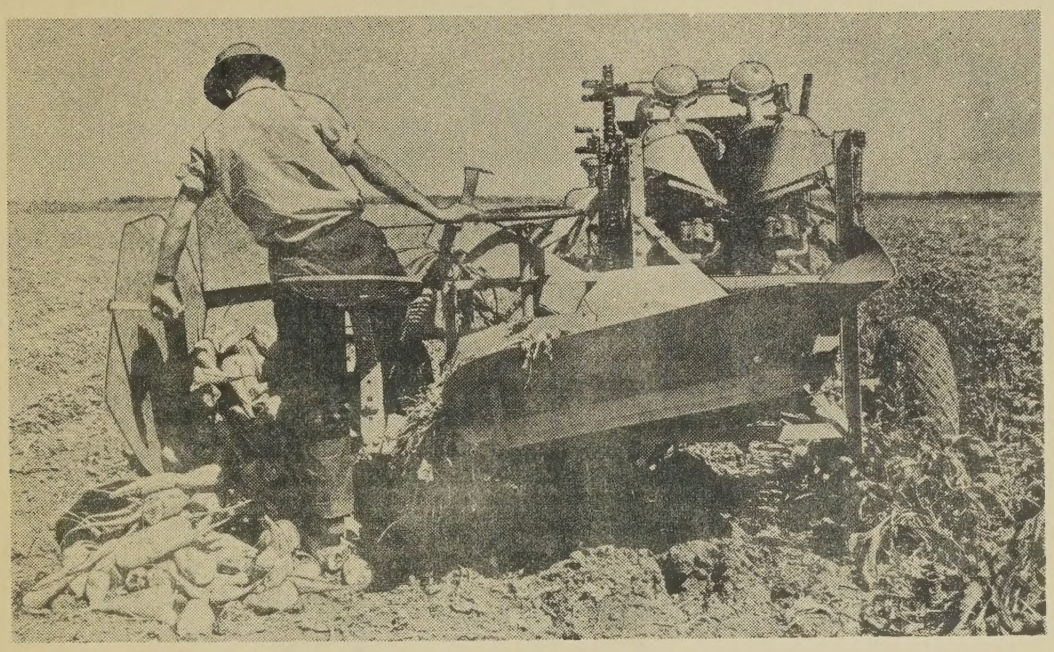
A crust breaker has recently been developed which has proved very effective in handling the situation. It consists of units made up of small, spiked wheels similar to rotary hoe wheels. The wheels are alternately 10 and 11 inches in diameter, the larger wheels fitting loosely enough on the shaft so that all wheels touch the ground. This provides a self-cleaning feature. A set of these units covering each beet row is mounted on an ordinary beet cultivator. Repeated tests have proved these crust breakers to be very satisfactory.

Bed planting of sugar beets is a new practice creating a demand for some new type equipment. It originated in California in 1930 and 1931 and is increasing in popularity in some of the irrigated districts. It consists of listing up ridges on 40-inch centers, harrowing them down in the spring and planting two rows of beets on the flat topped beds which are approximately six inches high. The practice originated in head lettuce growing and in general the lettuce planting equipment of sled bed planters, cultivators, etc., is used. This method of planting when applied to sugar beets presents a spring problem of clean-up of weedy, over-winter beds. Equipment is being developed to meet this situation of weed control as well as others arising from the application of the practice to sugar beets.

1. - A field of hill planted sugar beets on the peat land of the Sacramento Delta just before being thinned, showing blanks.



2. - Sugar beet harvester successfully handling a 22 to 25 ton per acre crop.



3. - Topping of the beets was equally as good as hand work.

4. - The new crust breaking units mounted on an ordinary beet cultivator were very effective.

5. - Bed planting of sugar beets necessitates the development of new equipment.